A
DESCRIPTION
OF THE
SELENOGRAPHIA:

AN APPARATUS FOR EXHIBITING
THE PHENOMENA OF THE MOON.

TOGETHER WITH

AN ACCOUNT OF SOME OF THE PURPOSES
TO WHICH IT MAY BE APPLIED.

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A DESCRIPTION

OF THE

SELENOGRAPHIA.

THE Selenographia consists of a Globe, on which are expressed the spots which appear on the moon's visible surface, accurately taken by a micrometer from the moon itself, and transferred to a globe. The papers which cover this globe are carefully engraved from the original drawings, made by a long series of very minute observations; the lunar mountains being attended to, and expressed with great exactness.

This globe is fixed to an instrument, contrived to give it such motions as will exhibit all the appearances which the face of the moon puts on to the inhabitants of the earth; whether occasioned by the different degrees of elongation from the sun, or its various states of libration, both in longitude and latitude.

Upon this globe (when required) are modelled the mountains, or elevations on the surface of the moon; by which contrivance, all the effects will be most completely exhibited together. As an appendage to these lunar globes, which have not the mountains elevated on them, a spherical segment has been invented, to be cast in a mould from the original model. Upon this segment, the various mountains seen on the surface of the moon are raised; and both it and the globe may be so coloured that those spots of the moon may be properly represented, which owe their luminous, or their dark appearance, not to elevation, but which are rendered conspicuous by other causes.

Besides the evident use of an accurate delineation of the moon for astronomical purposes, particularly for the observation of lunar eclipses, it cannot but be considered as an object of great curiosity, that we should have an authentic record of the appearance of this our secondary planet at a certain period; for although the face of the moon has not appeared to be subject to much change, since the invention of the telescope has given us the means of accurately investigating it, yet there are strong reasons for supposing it is not absolutely immutable; nor is it possible to say how precious, in future times, such a representation as this may become.

Hevelius, the diligent observer of the lunar phases, at the end of his Selenographia, published in 1647, has strongly recommended such a globe as this; but we do not find any attempts were made toward its execution (though so much desired by that great man, who spake of its utility), until the year 1745,* when we are told it was begun, and for several years pursued, by that most eminent astronomer Tobias Mayer. The editor of his posthumous works observes, respecting these intended lunar globes, " that it may possibly afford posterity some consolation, though indeed but small, that the work was not obstructed by the death of Mayer; but that, being engaged in other discoveries, and for reasons it would concern but few to have related, that learned man had laid it aside a long time before his death; and indeed in such a manner, as it is related to me by his friends, that he expressed himself much displeased if any one inquired after his lunar globes."—*Vol. I. page* 105. *Appendix.*

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* La Hire, in France, is said to have constructed a lunar globe, but it never was made public. See De la Lande, Vol. III. page 310. 3d edition.

The advantages which the lunar globe has over common prints, or drawings of the moon, were considered by Hevelius and Mayer to be very great: and this opinion will appear the more reasonable, if we consider, that while a flat representation describes the moon only at one given moment, from which it is continually deviating, the lunar globe represents it at all times, and under all circumstances. It is indeed difficult to say how seldom the moon returns to that state, in which it will have *perfectly* the same appearance it had in any former instance. If, for example, an absolute mean state of libration be inquired after; the moon, to produce such a state, must not only be in the line of the apsides, but that line must coincide with the line of the nodes of the moon's orbit, and also with the line of the nodes of the moon's equator;* and as the diurnal and menstrual libration, arising from the lunar parallax, is considerable, the earth must present the same point of its equator to the moon, at the same time when those other circumstances of her situation may concur; which can happen but in very rare instances.

It may, perhaps, be objected, by some who have not considered the matter thoroughly, that a small error committed in measuring the sides of triangles on the moon's surface, by a micrometer, may produce a very considerable one in transferring those triangles to the surface of a globe, especially near the boundaries of the moon's disk; but those who consider the business maturely, will readily see that no greater error can be committed here, in the apparent place of a spot, than occurred in the original measurement, because the lunar globe is intended to be viewed in the same manner the moon itself was viewed in making the observation: granting, however, the objection to have weight in it, it must apply equally to any representation of the moon whatever. The author wishes further to suggest, that as the libration gives different views of the same measurement at different times, there arises from hence, an opportunity of discovering any mistakes that may be made, and of correcting them when the spots are laid down on a globe, which the other way of representing the moon does not so well admit of. This might be demonstrated; but a little reflection will render a formal demonstration unnecessary. To be absolutely certain that a drawing of the moon in plano is correct, we must wait until the moon itself is in the same state of libration, to compare it with the drawing or print that it was in, when the drawing was made; but the lunar globe being viewed with a telescope at the proper distance, it may be compared with the moon at any time, and its merits or demerits may thus be directly known.

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* A mean state of libration in *latitude* may happen by the obliquity of the moon's equator counteracting the effect of her declination.

Many agreeable as well as useful experiments may be made during such a comparison. Upon the globe of the moon are faintly marked three great circles; one horizontal, and the other two vertical. That which is horizontal represents the moon's equator; it passes over that spot which is named Sensorinus, and runs about three degrees to the northward of Grimaldus. The second is the prime meridian; which, passing through the poles, intersects the equator at right angles, in that point which is the mean centre of the moon's libration, and is east of Sensorinus *thirty-two degrees forty-five minutes*, determined by T. Mayer. The third represents the boundary of vision, when the moon is seen in the mean state of libration; the two points where this boundary intersects the prime meridian, at right angles, are the two poles of the moon, each of which is, of course, ninety degrees distant from the moon's equator.

OF THE LIBRATION OF THE MOON.

Observations have shewn that the plane of the circle, here called *the prime meridian*, has a continual tendency to pass through the upper focus of the lunar orbit; or, in other words, that focus which the earth is not in;* and, on this account, the same side of the moon, nearly, is always turned toward the earth. Had the tendency of this meridian been to the lower focus, the plane of the moon's orbit coincident with the plane of the ecliptic, and her axis of rotation perpendicular to it, we should then have continually seen the same face of the moon, without the least variation, except what arises from her parallax, and which will be taken notice of hereafter.

When the moon is in either apsis, the plane of the prime meridian being directed to one focus of her orbit, must necessarily pass through the other also. But, during the time she is moving from the apogeon to the peregeon, the prime meridian being still directed to the upper focus of her orbit, a meridian of the moon, which is to the eastward of that, will be directed to the earth; and, of course, an inhabitant of it will see a part of the moon's surface, which is to the eastward of any he saw when she was in the apogee, and will have lost sight of a part he then saw toward her western limb. This part of her surface will increase till she arrives at a certain point of her orbit, after which it will decrease till she comes to her peregeon, when she will shew the same face (in respect to east and west) that she did when she was in apogee. In passing from the peregeon to her apogeon, a meridian which is to the westward of the prime meridian will be directed toward the earth, and an inhabitant of it will see a part of the moon's surface which is to the westward of that he sees when she is in the apses. This variation amounts to about seven degrees and an half each way, or about fifteen degrees in the whole, and is called the moon's *libration in longitude.*

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* See Gregory's Astronomy, Vol. II. page 650.

Again, the plane of the moon's orbit being not coincident with the plane of the ecliptic, but inclined to it in an angle of about five degrees and one-third, and cutting it in two points, called the nodes of the moon; it is manifest that when the moon is in either of those nodes, it will be in the plane of the ecliptic; and, consequently, the view which a spectator on the earth has of the moon's surface will be bounded by a circle which is perpendicular to the plane of the ecliptic. But the moon, leaving one of these nodes, and passing through that part of her orbit which is north of the ecliptic, will be raised, as it were, above it, and a spectator on the earth will have the boundary of vision on the moon's surface nearer to him on the northern side, and farther from him on the southern side, than it was when the moon was in the plane of the ecliptic. On the contrary, the moon having passed the other node of her orbit, and got into that part of it which lies south of the ecliptic, the same spectator will be able to see farther on the northern side, and not so far on the southern side of the moon, as he did when she was in the nodes of her orbit. The quantity of this variation is about five degrees and one-third each way, and is called the moon's *libration in latitude*.

But the moon's libration in latitude is subject to variation from another cause. The axis, about which the moon revolves, is not perpendicular to the plane of the ecliptic, but is inclined to it, according to M. De la Lande, in an angle of about eighty-seven degrees and an half; or, in other words, makes an angle of about two degrees and an half with the axis of the ecliptic, when they are in the same plane. On this account the moon's libration in latitude will sometimes be more, and sometimes less, than five degrees and one-third by that quantity: consequently, the moon's libration in latitude may amount to about seven degrees and five-sixths each way, or about fifteen degrees and two-thirds in the whole, when greatest.

OF THE APPARATUS FOR MOVING THE LUNAR GLOBE.

A brass hemisphere is placed upon a stand, to which the globe, and all the parts which give it motion, are attached.

The parts which are intended to give motion to the globe consist chiefly of circles, semi-circles, and segments of spheres; all which are so placed as to have one common centre, namely, that of the lunar globe. The bar which communicates motion to this globe from the other parts of the machine, enters it opposite to that point where the equator and prime meridian intersect each other; called here the *mean centre of libration.*

On the front of the globe there are two semi-circles, which being graduated, determine the quantity of motion given to it by the instrument. These are attached to a graduated circle, which is let into the front edge of the brass hemisphere, and represents the general boundary of vision; one of the semi-circles above mentioned, is fixed at right angles to it, and is called the ecliptic; and the other, which is moveable, is at right angles to the ecliptic, and called the terminator, representing the boundary of light in all states of the moon's elongation from the sun. This terminator is designed to shew what spots appear in the edge of the moon's illuminated disk, at any age of the moon, in any state of apparent polar obliquity, and in every degree of libration both of longitude and latitude.

Upon the edge of the brazen hemisphere are two marks, to denote the poles of the ecliptic, round which, by means of a wheel, the poles of the moon's equator are made to revolve; and are kept at the distance of two degrees and an half, by means of a pin, placed out of the centre of that wheel, and fixed in one end of an arm of brass, called by the inventor the polar guide; into the other extremity of the polar guide is inserted one end of the bar, before mentioned, which enters the lunar globe. On the wheel are the signs of the zodiac, to shew the points of space to which the moon's polar axis is at any time directed; and also a moveable circle, on which are engraved divisions, shewing how far the moon is advanced, at any time, in her periodical revolution, as seen from the centre of the earth. On the same circle there are likewise engraved the divisions of the moon's synodical revolution, by a continuation of the divisions which mark the former, in a spiral direction, within them; thereby marking the days, hours, &c. which are wanting to fill up the interval between the accomplishment of the periodical and synodical revolutions; one index pointing to both.

In front of the lunar globe, and fixed to the bottom of the brass hemisphere, there is an arm which supports a small terrestrial globe, to render the effects of the moon's parallax, that is, the diurnal and menstrual libration, familiar to those who may not have considered these things maturely. For the convenience of observation, this terrestrial globe is made somewhat larger than the earth really appears to be from the centre of the moon, but converging lines reduce it to its proper size; the particulars of which will be found under the head of Diurnal and Menstrual Libration.

Many curious experiments may be made with this apparatus, tending to examine the principles of the rotation and libration of the moon, from the appearance which the surface of the moon exhibits to a spectator on the earth, and which are all represented by it, in a very natural manner. Besides which, it is apprehended the apparatus will be very useful to those who are just entering upon the consideration of this subject, in being the means of communicating to such persons general knowledge, in a more ready and more agreeable manner than by the usual diagrams; as well as particular and curious circumstances; some instances of which are submitted for the consideration of those who are disposed to examine the apparatus.

OF MEASURING THE DISTANCE OF SPOTS ON THE SURFACE OF THE LUNAR GLOBE.

Those who use this apparatus, will observe the little crosses which are engraved within thirty-four of the best known spots on the globe, named by Ricciolus, Plato, Tycho, Pitatus, Copernicus, Bullialdus, Aristarchus, Grimaldus, Schickhardus, Mercurius, Langrenus, Endymion, Censorinus, Fracastorius, Zoroaster, Catherinus, Theophilus, Cyrillus, Hercules, Atlas, Petavius, Erastosthenes, Keplerus, Gassendus, Aristoteles, Hevelius, Clavius, Archimedes, Cleomedes, Possidonius, Blancanus, Menelaus, Heraclides, Arzachel, and Ptolemæus,* with which, such as wish to examine the moon will do well to make themselves acquainted. They will be found sufficient to form triangles, so as to describe any part in their vicinity which may be needful to remark, without being perplexed with more. For instance, if the position of any spot is to be determined between

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* There are a great number of spots, to which names have been given by Hevelius and Ricciolus, but it has been found very troublesome to distinguish some of these spots by their names. Those, however, which are here selected for the purpose of measuring from, are easily recognized; and in using the method now proposed, the mind will be freed from the embarrassment which the usual Nomenclature has sometimes occasioned. These spots will be readily known from the diagram at the end of this explanation.

Copernicus, Plato, and Aristarchus, by loosening the screws and turning the brass circle, which is let into the edge of the hemisphere, the graduated terminator, fixed to it, may be brought to that part of the surface of the lunar globe, and its edge made to pass over the spot, of which the situation is to be determined; and each of the other three in succession, and the degrees intercepted between these and the required one, will determine the situation of it. When occasions may require it, as in the passage of the earth's shadow during an eclipse, &c. measuring thus by the graduated semi-circle, will prevent the globe from being injured by the frequent use of compasses. The situation of an unknown spot may be determined by its distances from any two, which are known, if it be added, that it lies above or below, to the right or to the left, of the line which joins the known spots; but taking its distance from three known spots will render remarks of that nature unnecessary. When the lunar globe is viewed through a telescope (by which it becomes a pleasing and deceptive object), the brass circle and semi-circles must be taken out of the hemisphere, and the small terrestrial globe turned on one side, which may be done if the left screw be taken out from the bottom of its support. The object-glass of the telescope must be placed about one hundred and forty feet from the globe, which will exhibit, in proper diameter, a similar effect to the moon's face at her mean distance from the earth. For a more careful observation with the telescope, where the micrometer is to be used, an exact calculation of the moon's distance must be made, and the lunar globe set at a proportionate distance from the telescope, allowing about *six inches to every thousand*

English miles: or the angle which the moon subtends at the time of observation being taken by a micrometer, the lunar globe must be moved nearer to, or farther from, the telescope, until its diameter appears under the same angle, and set in respect to libration as the moon presents itself; then the measurements are to be made. The observations on the spots of the moon, when they are in the line which separates the light from the dark part, will greatly assist in the examination of this globe, if due attention be paid to the state of the libration, and to the use of the brass terminator for the phases. Should any person be desirous to prove the exactness of this globe, by comparing it with the moon, the Author begs leave to invite them to it; and submits his labours to such an examination; it is for that purpose he points this method out: for, notwithstanding he may have committed some trivial errors, which the multiplicity of parts can scarcely fail to have occasioned, he is well assured that the approbation of the Public will increase in the same proportion as it is examined.

It will greatly facilitate the general knowledge of the lunar disk if particular attention be given to the *equator*, the *prime meridian*, and the *boundary of vision*, the three great circles already mentioned, to be represented on the lunar globe, under all the various positions they may be moved into by the instrument.

LIBRATION IN LATITUDE AND POLAR OBLIQUITY.

The equator is made to rise and fall in the front of the lunar globe, to the extent of ten degrees and two-thirds, by turning the lower rack in the hinder part of the instrument, and the graduation on the lower pinion will shew how much it is elevated or depressed. When at O it represents the moon in the line of the nodes, and when at five degrees and one-third, on either side, it exhibits the moon at her greatest latitude, either north or south, when the axis of the moon's equator is in the edge of the brass hemisphere. By turning the rack on the top, which moves the wheel, that way which the engraved dart upon it directs, the equator of the lunar globe will be alternately raised and depressed, in front, five degrees, while the lunar poles move in circles of that diameter. The motion, thus given by the wheel, will not only raise and depress the moon's equator, at the same time that it gives its poles a circular motion round the poles of the ecliptic, but it will also alter the position of the circle called the prime meridian, giving it different degrees of inclination to the plane of the ecliptic; but those different inclinations cannot vary more than two degrees and an half each way from the perpendicular, the quantity which it raises or depresses the moon's equator.

This singular motion, which the Selenographia represents very clearly, arises from the obliquity of the moon's polar axis; the graduations on the terminator, in front of the instrument, will express the amount of the libration of the equator in latitude, resulting from the compound effects of the moon's latitudes and polar obliquity; neither of which produce any libration in longitude. By this instrument it will be seen, that the libration of the moon in latitude exceeds her libration in longitude by about two-thirds of a degree: this will appear by comparing several revolutions with each other; for notwithstanding the libration in longitude may be always about fifteen degrees, while the libration in latitude may sometimes not amount to six degrees, on account of the inclination of her orbit being subject to change, and the polar obliquity sometimes counteracting the effect arising from her latitude; yet, as these two causes, at other times, conspire to increase the effect of her latitude, the whole libration in latitude will sometimes amount to near sixteen degrees; and the power of the instrument, to imitate these librations, will afford much pleasurable instruction to those who have not before well considered them.

LIBRATION IN LONGITUDE.

The prime meridian of the globe is moved horizontally by turning the middle rack; which admits of being moved fifteen degrees. By this means, and attending to the graduations on the brass ecliptic in the front, the globe may be set answerable to any state of the moon's libration in longitude. When the prime meridian is at O on the brass ecliptic, the globe is then in a mean state of libration in longitude. This being a simple motion to exhibit the phenomenon of the moon, respecting the line of the apsides, it is thought the circumstance itself, as well as the mode of representing it, will sufficiently appear, from barely viewing the instrument, without any further observations concerning it; and especially to those who consider that the moon's orbit is an ellipsis, in which her motion is unequal; while her rotatory motion on her axis is supposed to be uniform; and that, in consequence, the plane of one of the moon's meridians will always pass through the upper focus of her orbit.

MEAN STATE OF LIBRATION.

In order to understand the other great circle on the lunar globe, mentioned above, namely, the boundary of vision, in a mean state of libration, an inspection of the globe itself may also be sufficient; as it will readily appear from thence, that the latter circle is at ninety degrees from that point where the other two great circles, already noticed, intersect in the front of the globe. The boundary of vision will be under the edge of the brass circle, when the lunar globe is set to a mean state of libration. The poles of the moon's equator will then be removed two degrees and an half on one side from the poles of the ecliptic, represented by two marks diametrically opposite each other, north and south, upon the edge of the brass hemisphere; at which time the polar axis will appear at its greatest inclination; and the equator will be seen on one side above, and on the other beneath, the edge of the brazen ecliptic, when that is properly adjusted, and set at right angles to the line supposed to be drawn through the two points which represent its poles. By making the various adjustments here spoken of, to these three principal circles of the globe, the most inexperienced person may discover that the moon cannot appear in its mean state of libration to any part of the earth, but when the common section of the plane of the moon's equator and that of the prime meridian, are directed toward that point.

ROTATION OF THE MOON ON ITS AXIS.

It is generally allowed that the moon's rotation on her axis is equable; but of this circumstance astronomers seem to think there has been no absolute proof. This instrument will afford the means of determining whether it is equable or not.

The rotation of the moon upon her axis being performed in the same period of time as the revolution in her orbit, namely, in twenty-seven days seven hours and forty-three minutes; if the axis of her equator had been perpendicular to the plane of the ecliptic, her equator being divided into twenty-seven parts, with an allowance of about one-third for the seven hours, &c. (beginning at any great circle of the moon, which may happen to be the boundary of the illuminated hemisphere at the time of an observation), that boundary would reach the first of those divisions in twenty-four hours. But as the moon is not a direct sphere, but has her axis inclined to the axis of the ecliptic in an angle of about two degrees and an half, a line passing through the moon's centre, parallel to the axis of the ecliptic, and not the axis of the moon's equator, will be that round which the plane of the moon's illuminated hemisphere will revolve; and a kind of undulating line, on the moon's surface, drawn through the several points of it, as they come into the plane of the ecliptic, will be that which ought to be so divided, did this line return into itself at the end of each revolution. But, on account of the tendency which one of the lunar meridians (the prime meridian) has to that focus of the moon's orbit which the earth is not in, and the periodical revolution differing from the synodical, this line will not return into itself, and consequently cannot be divided in the manner required. Moreover, on account of the apparent variation of the inclination of the moon's polar axis to that of the ecliptic, the boundary of the moon's enlightened hemisphere will not fall on the same spots at the same period of different synodical revolutions; nor will that boundary have the same inclination to the prime meridian, till after many revolutions. This difficulty, however, the instrument will help us to overcome, by attending to the following precepts.

Observe what spots on the moon are cut by the plane of illumination. Find those spots upon the lunar globe, and place the brass terminator on any one of them situated near the equator of that globe; turn the wheel on the top of the instrument until the terminator receives the rest of the spots under it which had been observed to be in the edge of the moon's illuminated disk. Then set the zodiacal circle, by means of the index, to the sign and degree, &c. in which the moon is at the time of the observation; and this *circle* must not shift its place *on* the wheel, until the series of observations are completed.

In twenty-four hours time the next observations are to be made; first noticing the sign, &c. into which the moon is then arrived, and move the wheel on the top of the instrument until the proper sign, &c. reaches the index. Then move the terminator to cut those spots of the lunar globe which appear at that time in the edge of the moon's illuminated disk, and note the degrees it is moved over on the brass ecliptic from the situation it was in at the time of the former observation. Repeat this operation daily; and if the degrees which the terminator moves over be always the same, the author apprehends the moon's rotation on its axis must be equable.

In the solution of the preceding problem it will be a circumstance of a curious nature, to observe what changes take place in the angle between the plane of the moon's illuminated disk, expressed by the brass terminator, and that of the prime meridian of the globe; and how much more clearly it will be by this means expressed, than by the diagrams usually employed.

OF THE PERIODICAL AND SYNODICAL REVOLUTIONS, WHAT CHANGES TAKE PLACE IN THEM, AND HOW TO DETERMINE THE POSITION OF THE MOON'S POLAR AXIS.

The wheel on the top of the instrument has circles described on it, and these circles are divided into the signs of the zodiac, and the degrees of the periodical and synodical revolutions. By the use of these, which are capable of adjustment, as hath been already noticed, the changes that take place in the libration and elongation between the accomplishment of the former of these revolutions and that of the latter may be determined. Beside which, these circles will assist to determine the points of space, amongst the fixed stars, to which the ends of the lunar axis are directed at any time. In the pursuit of this, let the globe be adjusted to the state of the moon's libration in longitude at the time of observation, and also the lunar equator to its proper elevation above, or depression below, the ecliptic at that time. Then adjust the globe, by means of the wheel, to the proper state of the moon's apparent polar obliquity, and turn the zodiacal circle upon the wheel, until the sign, degree, &c. in which the moon is situated in the heavens, is brought to the index under the polar guide. Let a line be then traced from the centre of the wheel through the pin inserted at the end of the polar guide, and that line will terminate in the sign to which the north pole of the moon inclines; and the south pole will incline to the sign opposite. If the moon's axis be inclined to the axis of the ecliptic in an angle of two degrees and an half,* the poles of the lunar axis must be directed to those points of space which are situated two degrees and an half north and south from the poles of the ecliptic. These operations, however, must only be considered as made in the gross; but many such, thus made, may assist in the examination of a subject which has been disputed; whether that slow change in the direction of the moon's equator, which is similar to the precession of the equinoxes (though it does not arise from the same cause), coincides with, or is more or less quick in its retrograde motion, than the line of the nodes of the moon's orbit. See observations concerning this subject by Hevelius, Cassini, Mayer, M. De la Grange,

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* If the axis of the moon be found to decline a little more or less, from the axis of the ecliptic than two degrees and an half, there is a screw near the centre of the wheel for adjusting the instrument in this respect.

P. Boscovich, and M. De la Lande, in *Astronomie* par M. De la Lande, 2d. Paris ed. 1771. from article 3174 to 3206.

The motions hitherto described, and given to the lunar globe by means of the instrument, are those which the moon possesses in consequence of the various positions of the line, which may be supposed to be drawn from the centre to the point where the prime meridian intersects her equator, during a revolution of the moon in its orbit. Had this line been permanent, no change in the face of the moon would then have been perceived, but that of her progressive illumination, arising from the different degrees of her elongation from the sun, and the libration caused by her parallax, in being viewed in different situations on the surface of the earth, which remain yet to be considered, and the effects shewn by the instrument.

DIURNAL AND MENSTRUAL LIBRATION.

As the subject now under consideration arises not from any motion in the moon; but from an alteration in the spectator's situation, and the motion of the earth; the effect is not given by any motion of the lunar globe itself, but by the motion of a small terrestrial globe, which, with its appendages, is supported by an arm occasionally screwed to the bottom of the brass hemisphere, and rising in front of the lunar globe high enough to support the centre of the terrestrial globe in the plane of the brass ecliptic. This will exhibit another kind of apparent motion, called the diurnal libration of the moon. The angle which the earth subtends from the centre of the moon, is not more than two degrees of the moon's circumference; but, for the convenience of observation, a size much larger than two degrees of the lunar globe is here adopted, that the effects may be better observed upon the small terrestrial globe. This globe, however, is reduced by two converging lines, which are tangents to the terrestrial globe, to two degrees at the periphery of the lunar globe; and the whole is so placed that the line which bisects the angle formed by the tangents, would, if produced, pass through the centres of both globes.

The zodiacal signs, &c. are engraved on a revolving plate, with an index pointing to the sign which the earth is seen in from the moon. This will render many circumstances relative to the rising and setting of the moon, the position of her horns to the horizon, the harvest moon, &c. very familiar to the observer;* and these circumstances, however well known to astronomers, may be acceptable to some persons, who have not given previous attention to the subject: but this is not the chief design. On the top of the small terrestrial globe, at the north pole, is fixed an hour circle, by which it is turned on its axis from west to east; and by that means exhibits to the view of the observer the diurnal libration of the moon. For example, let us suppose the moon in the equinoctial, and that it were requird to shew the diurnal libration, as it will appear to a spectator situated where the earth's equator is cut by the meridian of London. Turn the small terrestrial globe on its axis, by means of the hour circle, and when the moon becomes visible to the spectator, it rises: at which time a spectator, having the moon then in his zenith, will see the centre of her disk about a degree

* Vide Ferguson's Astronomy.

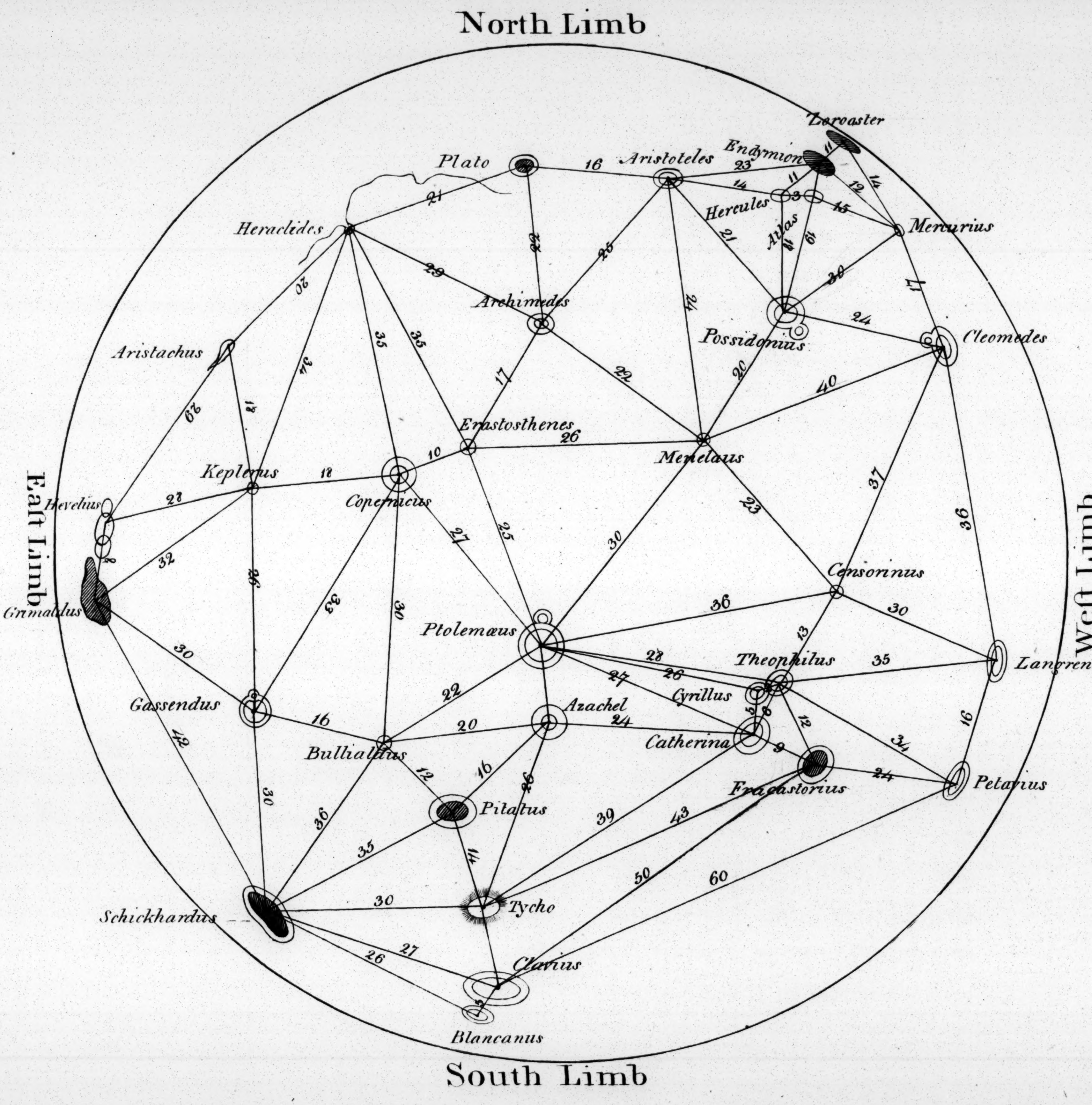
(reckoned on her surface), to the east of the place it appears in to the spectator, who is on the equator, and under the meridian of London. On the contrary, if we suppose a spectator situated in the point which is directly opposite to that where the spectator under the meridian of London is situated; such spectator will have the moon setting, and the centre of her disk, as it appears to him, will be a point almost a degree still farther east than the point which is taken for the centre by the spectator who has the moon in its zenith.

The diurnal libration here treated of is the effect of the moon's horizontal parallax; and will, when the moon is in the equinoctial, be always equal to that parallax (reckoned on the moon's surface), to a spectator situated on the earth's equator. If the spectator be not situated on the earth's equator the quantity of this libration will be less and less, as the spectator approaches the poles of the earth, where it becomes nothing.

There is yet another species of libration to be taken notice of arising from the obliquity of the earth's axis; or, which is the same thing, from the moon's declination. This libration is menstrual, and the quantity of it will be equal to the angle at the moon's centre, subtended by a chord of forty-seven degrees on the earth's surface, and therefore will amount to something more than three-quarters of a degree of a great circle on the moon's surface. It may be represented very familiarly by turning the terrestrial globe by means of a pinion that acts on the teeth of the horizontal wheel, contrary to the order of the signs, as directed by a dart on the pinion.

One thing further remains to be explained. A small wire is inserted into the terrestrial globe at the point of it which

6


North Limb
Zoroaster
Endymion
Plato
Aristoteles
Hercules
Atlas
Mercurius
Heraclides
Archimedes
Possidonius
Cleomedes
Aristachus
Erastosthenes
Menelaus
Keplerus
Copernicus
Hevelius
East Limb
Grimaldus
Censorinus
Ptolemæus
Langren
West Limb
Theophilus
Cyrillus
Gassendus
Azachel
Catherina
Bullialdus
Fracastorius
Petavius
Pilatus
Schickhardus
Tycho
Clavius
Blancanus
South Limb

represents London, and perpendicular to its surface, but which may be changed to any other part of that globe, at the option of the possessor. This wire points out the direction of the zenith of the place at every point of the earth's revolution on its axis; and, by comparing it with the illuminated part of the lunar globe, shews the position of the moon's horns with respect to the horizon of that place.

As a caution to those who have the complete instrument, it may be necessary to observe, that the semi-circle which represents the ecliptic must never be moved, until the *screws* which fix the arm carrying the terrestrial globe to the brass *hemisphere* and to the *ecliptic* be taken out, and the arm turned on one side, as directed in page 11.

The use of the annexed Plate, containing the names and arrangement of the principal spots of the moon's surface, will be obvious to every person who is in possession of one of the lunar globes. These spots are proposed to be taken as a basis from which the situations of other spots are to be determined by measurement, when they are wanted occasionally. The distances are put down to degrees only, without fractions, which are sufficient to determine the corresponding spots on the surface of the lunar globe, and render them familiar to the observer. They are distinguished, on the lunar globe, by small crosses made in their centres.

Although the Inventor of the Selenographia, at a very early stage of the undertaking, submitted his drawings of fragments and diagrams to some of the most respectable astronomers and mathematicians in this and other kingdoms; who, after a strict examination, expressed themselves quite satisfied with the method which has been adopted; yet, for the satisfaction of those who are not acquainted with his method, the following account of it is given.

In the year 1785 the first efforts were made toward drawing the moon; and they were continued with unceasing attention until all the separate parts were drawn, under all the various circumstances of light and shadow. Attempts were then made to unite them properly together.

Measuring the distances of the spots on the moon's surface will not appear to be an easy task, when it is considered that the librations of the moon are perpetually altering the apparent distances of those spots from each other, as well as the apparent lengths of the arches of the parallel circles on which they are situated; and those who will try will find it, at the least, as arduous a task to bring the several parts together after they are drawn separately; because the whole cannot be seen when the state of illumination is such as will shew the elevated spots properly. To effect their due arrangement, various methods were tried; and the following was pursued, as that which appeared to be best.

Two diagrams were made from the moon during one revolution, each of them when she was in a gibbous state, and in a direct opposition to each other, in respect to illumination, and each of them at a time when the moon was at a considerable distance from the line of the apsides. The gibbous state was chosen, because at that time a greater number of the *eminences* on the moon's surface are distinguishable than when she is in opposition to the sun. Three distant spots, whose centres were shewn by the edge of the micrometer to lie in a right line, were selected as a base for the rest; and from these the distances of the other spots were measured, bringing the edge of the micrometer continually to pass over three or more spots at a time, as often as it could be done, and remarking where the intersections of such lines happened with those which had been drawn before. In one evening, by great diligence, a diagram of the principal spots was completed to the edge of the moon. Every line which passed through the centres of three spots was drawn in red ink; and those which only passed through two spots, and formed the sides of triangles to the red bases, were drawn in black ink. All the lines which formed these triangles were carefully and repeatedly measured by the micrometer; the diameter of the moon being ascertained at the time when each diagram was made; and which, being bisected, formed, of course, the radius by which a circle was struck for the outward margin of the moon in each. The inferior spots were afterwards supplied, in the same manner, by the intersection of lines drawn from the principal spots, and measured by the micrometer, as the moon came into a proper state of libration for that purpose.

Each diagram thus made, from actual observation, and laid down by scale and compasses, was covered with a net-work of squares, by means of which the spots were transferred, from the two diagrams, to two separate globes in the following manner. Assuming any point on the surface of one of these globes to represent the extremity of the vertical diameter of one of the diagrams; from that point, as a centre, parallel arches were described on the surface of the globe, with an instrument contrived for that particular purpose. These arches were described at such distances from each other that they corresponded to the lines of the diagram; and one hemisphere of the globe was by this means divided into as many parts as there were spaces between the parallel lines on the diagram. Then, by the same instrument, parallel arches were described on the same globe to correspond with the sides of the squares on the diagram which were perpendicular to the former. Hence the surface of the globe was covered with a net-work of square spaces, corresponding to the squares on the surface of the diagram. The surface of the other globe was divided into square spaces in the same manner.

By means of these corresponding squares the several parts of the surface of the moon were transferred from the diagrams to the globes: the eastern side of the moon being transferred to one globe, and the western side of it to the other. But, notwithstanding one globe represented chiefly the eastern, and the other the western side of the moon, as the diagrams were made when the moon was in a gibbous state, each of them included several spots about the centre of the moon's disk, which were common to both: these spots, among which were Plato, Tycho, Erastosthenes, and several others, were therefore common to both globes, and were the means by which those spots which were wanting to complete one globe were transferred to it from the other, in the following manner:

The distance of the spot which was to be laid down, from two common spots, being taken from one globe, was placed in the exact distance from the centres of the two corresponding common spots on the other globe; and on this principle all the spots wanting to form one complete globe, were transferred to it from the other by the instrument mentioned above, in the same manner as they might have been done with a pair of compasses, but with much more readiness if not with a greater degree of accuracy.

The *instrument contrived* to *move* these *globes* was invented by degrees, chiefly in the year 1796; and it is hoped will fully answer the purpose intended by it, namely, that of exhibiting, completely, all the effects of *libration*, *rotation*, and *elongation*, on the surface of the *moon*.

FINIS.

these spots [illegible]; and [illegible] transferred to it from the [illegible], in the following manner.

The distance of the [illegible] which are a little [illegible] two common spots [illegible] the exact distance from the centre of the [illegible] common spots on the other globe; and on this [illegible] the spots [illegible] complete globe, were transferred to it from the [illegible] same manner as [illegible] have been done with a pair of compasses, but [illegible] with a greater degree of accuracy.

The *instrument contrived to move these globes* was invented by degrees, chiefly in the year 1756; and it is hoped will fully answer the purpose intended by it, namely, that of exhibiting completely all the effects of diurnal rotation and progression, on the surface of the moon.